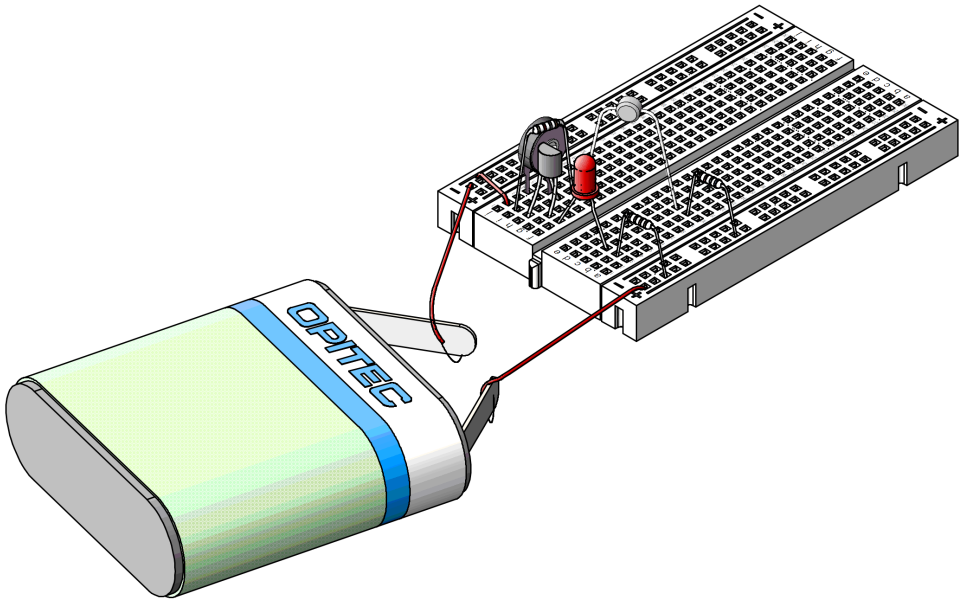
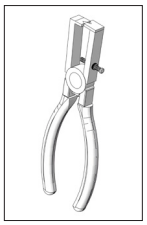
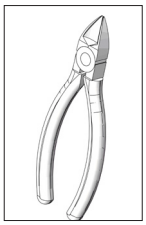
118406

Electronic Learning Programme Sensors with Breadboard



Tools Required:


Stripper


Side Cutters

Please Note!

The Opitec Range of projects is not intended as play toys for young children. They are teaching aids for young people learning the skills of craft, design and technology. These projects should only be undertaken and operated with the guidance of a fully qualified adult. The finished projects are not suitable to give to children under 3 years old. Some parts can be swallowed. Danger of suffocation!

Article List	Quantity	Size (mm)	Designation	Part No.
plug-in board/ breadboard	1	83x55	plug-in board	1
blade receptacle	2	6,3	connection to the battery	2
resistor 120 Ohm	1		series resistor	3
resistor 1,8 kOhm	1		resistor	4
resistor 2,2 kOhm	1		resistor	5
resistor 6,8 kOhm	1		resistor	6
thermistors 4,7 kOhm	1		thermistors	7
photoconductive cell	1		photoconductive cell	8
transistor BC 548C	2		transistor	9
elko 1000 µF	1		elko	10
LED red	1	ø 5	LED	11
trimmer 10 kOhm, horizontal	1		trimmer	11
jumper wire, red	1	500	jumper wire	12
jumper wire, black	1	500	jumper wire	13

OPITEC

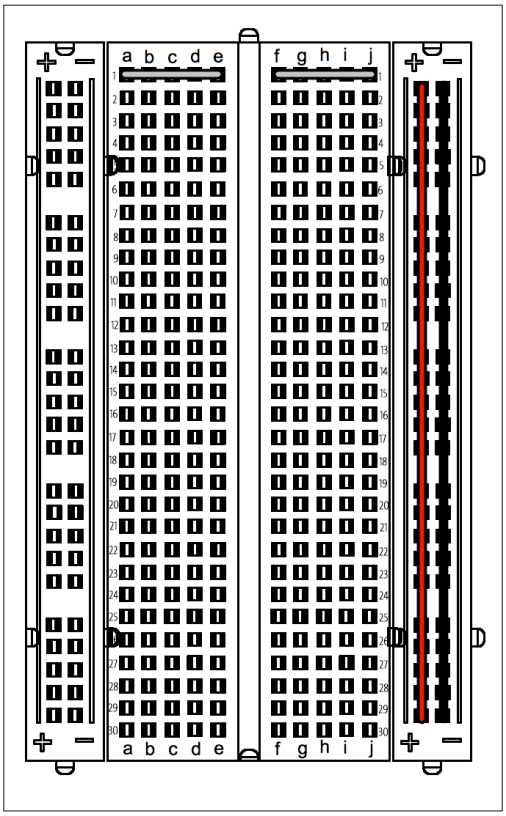
General:

How does a breadboard work?

The breadboard also called plug-in board - makes experimenting with electronic parts immensely easier. The components can simply be plugged into the breadboard without soldering them.
Circuits can be plugged directly onto the breadboard.
Because the production of a complete circuit board is very expensive, a breadboard is a quick and easy alternative.

Originally, the English term came from the first circuits, which were simply nailed to a wooden board. These wooden boards reminded of breakfast boards and thus the plug-in board was called breadboard.

The trick with the breadboard is that some of the holes on the breadboard are conductively connected to each other. In the representation of the breadboard on the right these connections are marked with lines. In the outer supply part these run in two parallel strips (+ and -) from top to bottom, while in the middle of the breadboard each 5 holes are combined horizontally to a column.



Between the rows a-e + f-g is a large gap. At this point, DIP-IC's can be plugged onto the board.
Other components such as resistors, capacitors or transistors etc. can be installed anywhere within the blocks. To connect them to each other, you can either put one leg of the components in a common row or work with wire bridges.

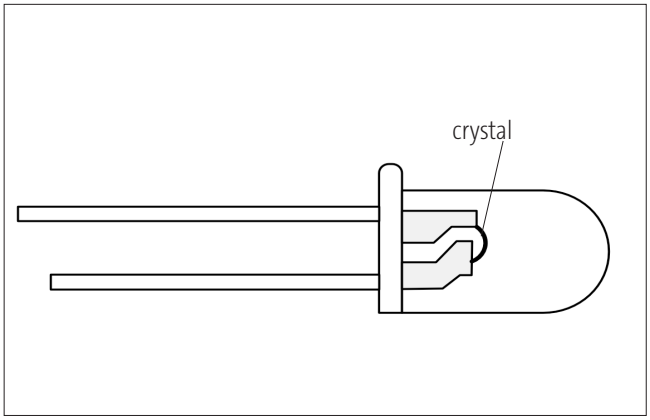
Most breadboards have a lateral power supply. Often, plus is marked red and minus by black.

Breadboards are a great way to quickly build new circuits. Though, there are some limitations:

- SMD components can not be used without additional adapters.
- Breadboards are not suitable for high voltages and currents.
- At a certain size, the circuits become confusing.
- Breadboards are only conditionally suitable for circuits with high frequencies.

The Light-emitting Diode LED

An LED is not an incandescent lamp. An LED is a semiconductor light emitting device. The light of a light-emitting diode is created by a small crystal, that emits electromagnetic waves which we can see.
If you hold a light-emitting diode against a light source (lamp, window) you can see the crystal inside.



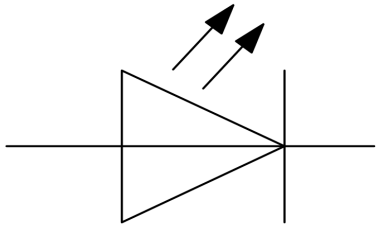
This lighting is very bright today, so that light diodes are used as flashlights, room lamps and in the car industry.
In most modern devices, LEDs are used as function display and function control, e.g. in MP3 players, computers, digital clocks, hi-fi systems and televisions.

Everywhere where small "lights" light up and show something, are light-emitting diodes. They are available in the colours white, red, yellow, green, blue and with colour change (RGB-Rainbow). The most common form is round, but light-emitting diodes are also used in quadrangular and triangular form.
The advantages of LEDs over small bulbs are:
- low power consumption
- vibration-resistant
- unbreakable
- very long service life
- low space requirement

It's called LED because of light-emitting-diode.
This abbreviation is used by electronics technician. Like all electronic components, the light-emitting diode also has a circuit symbol.

circuit symbol LED

The two arrows symbolise the emission of light.

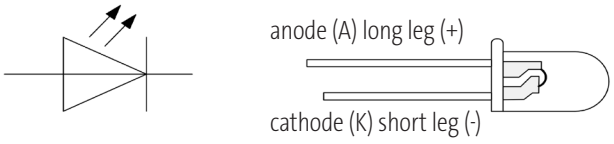


Caution:

If you want to make a LED shine, you must note following points:

1. The light-emitting diode must be connected with the correct polarity, otherwise it will not light up. For this purpose, the connections have been labeled ANODE (A +) and CATHODE (K-). The LED is too small to print the terms on it, so it can be seen on the connection legs, which wire is the anode and cathode
(see drawing!).

circuit symbol



The anode gets connected positive (+), the cathode minus (-).

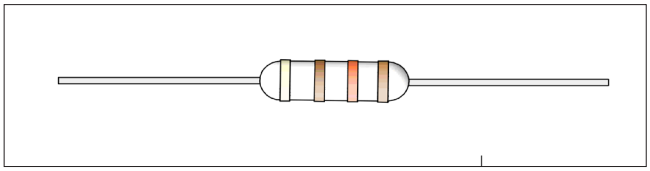
2. A commercially available light-emitting diode must never be connected to a voltage source with more than approx. 1.6 volts (today there are LED's with different voltage values which can be taken from the technical data sheets of the manufacturer), they would immediately "burn out". However, because a higher voltage than 1.6 volts is used in most devices and circuits, the voltage must be reduced to 1.6 volts via another electronic component. The required component is the RESISTOR.

Here is a list of the most common power sources and the necessary resistor values.

voltage	resistor
4,5 Volt	130 Ohm
6 Volt	180 Ohm
9 Volt	390 Ohm
12 Volt	510 Ohm
24 Volt	1,2 kOhm

The Resistor

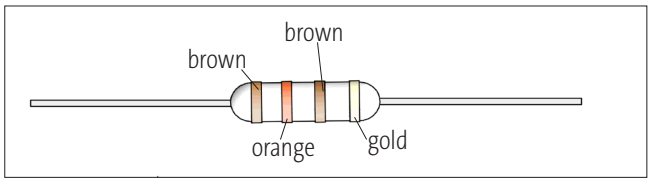
The resistor is an electronic component which restricts the current flow.
The most common resistors are made of carbon film on a ceramic tube (carbon is a poor conductor). At the beginning and end of the tube are connecting wires.



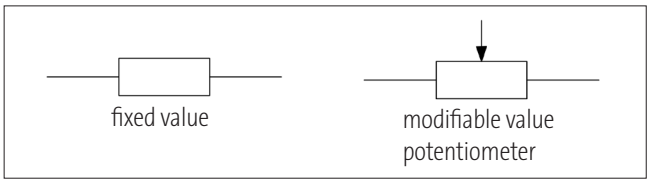
Coloured rings on the resistor show the resistance value.
This value is given in ohms (Ω) and indicates whether the resistor allows a large or small current flow.
A high ohmic resistor, e.g. 1.8kΩ (1800Ω) allows less current flow than a resistor of smaller ohmic value, e.g. 130 Ω.
With the help of the following table, it is easy to find out which ohm value the used resistors have.

ring colour	1. ring	2. ring	3. ring/ multiplier	4. ring/ tolerance
black	0	0	1	1 %
brown	1	1	10	2 %
red	2	2	100	-
orange	3	3	1000	-
yellow	4	4	10000	-
green	5	5	100000	-
blue	6	6	1000000	-
purple	7	7		-
grey	8	8		-
white	9	9		-
gold			0,1	5 %
silver			0,01	10 %
				without ring 20%

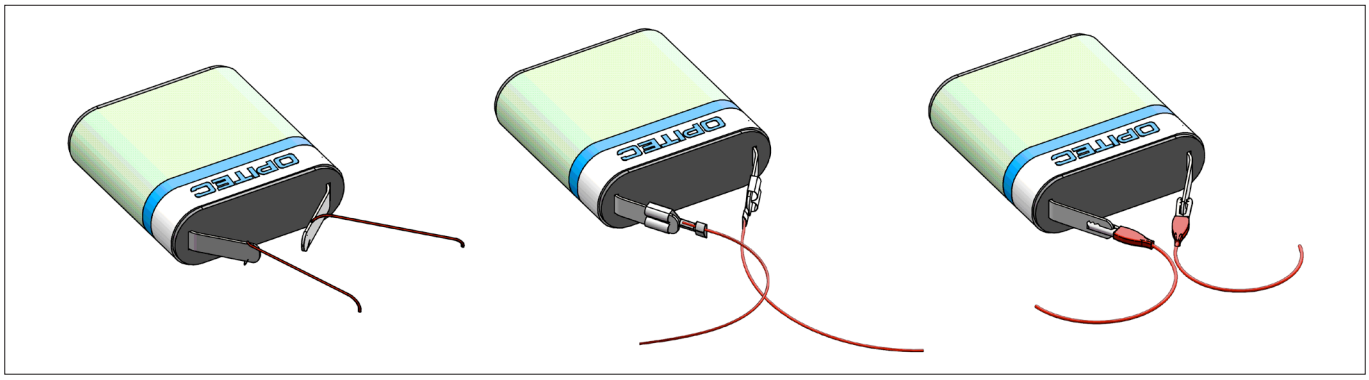
Example: 130 ohm with 5% tolerance



circuit symbol:



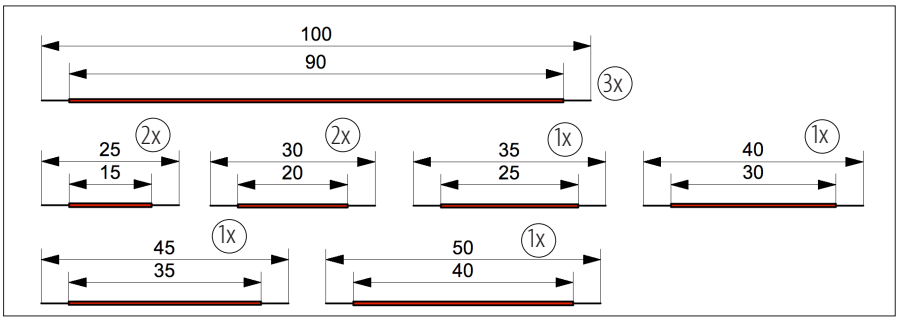
Possibilities for connecting breadboard and battery:



There are several ways to connect the breadboard to the battery. Separate two pieces from the jumper wire (approx. 110mm) and strip them on both sides. The wire ends can simply be attached to the battery by wrapping the - and + pole. Likewise, the wire ends can be enclosed to the attached blade receptacles (2) and then pushed onto the poles. Another option is to connect the wires with crocodile clips. The free wire ends are inserted in the breadboard in the respective bar for the + or - pole.

Cutting the cables for connections and bridges:

To build different circuits cable pieces are needed as connections and bridges. Cut them off the remaining jumper wire as shown and strip them on both sides.

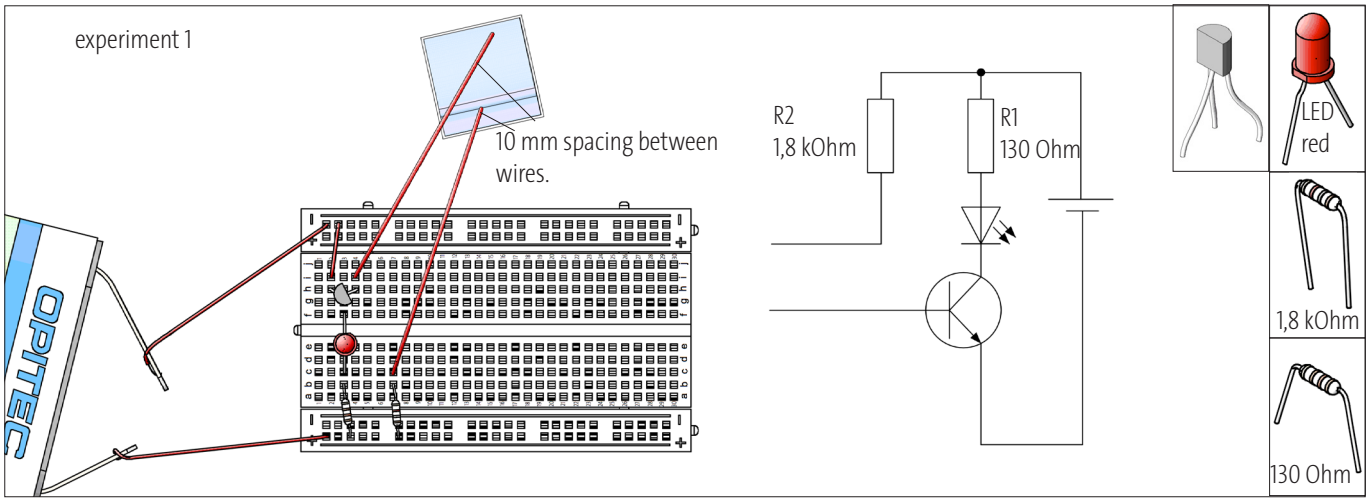


Instruction 118.406
Electronic Learning Programme Sensors with Breadboard

What is sensor technology?
Sensor technology can be used to describe the technologphysical quantities that can be detected and evaluated with the aid of sensors. Such sensors (sensors) react to liquids, gases, light, heat and other sensory substances.
With this learning program, the most important sensor technology processes are learned theoretically and practically. At the same time, the use of a circuit in the real technology is shown by examples.

Notes for circuits in this tutorial:
For all circuits, the LED can be replaced by a relay (# 214016). So other consumers can be connected. However, it must be connected in parallel to the relay a universal diode in the reverse direction. This "protection diode" protects the transistor from being destroyed when it is switched off.

Experiments with sensors:
Water march



Insert the resistor 1 (130 Ohm) between the +bar and terminal 3b. Plug in the anode of the red LED at terminal 3c and the cathode at terminal 3f. Place the transistor as follows: connect the base at 4h, the collector at 3g and the emitter at 2h. Plug in a cable connection between 2i and the -bar. Insert a cable (approx. 100mm) at connection 4i. Place the other end in a water container. Insert resistor 2 (1.8 kOhm) between +bar and 7b. Insert a cable (approx. 100mm) at 7c. Place the other end also in the water container.

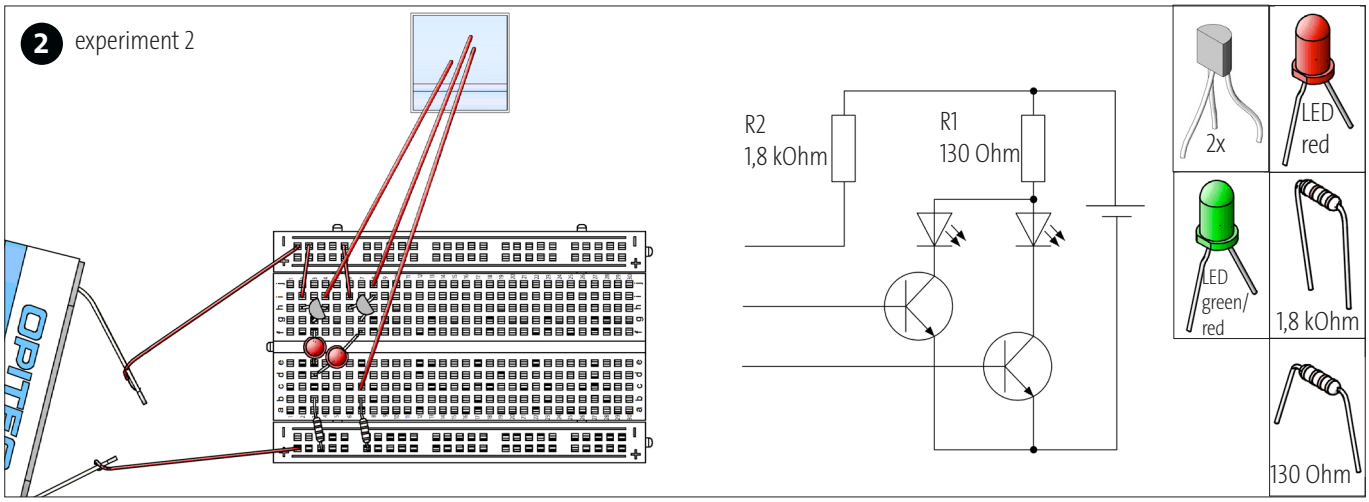
Function of the circuit:
If the battery voltage (up to 6V) is applied, then we have a positive potential of approx. 0.8V on the sensor wire. The base resistor causes the voltage drop. This voltage allows a small current (about 2 mA) to flow. Now, if wire 1 is brought into contact with wire 2, then the transistor turns on and the LED lights up. The circuit should serve as a sensor for conductive fluids. For this purpose, the wires 1 and 2 must be kept in a conductive liquid (water), wherein the distance of the wire ends may not exceed about 10mm.

The base stream will then flow through the liquid and be weakened due to its intrinsic resistance so that the lamp glows weaker. Without base resistance, the lamp would shine brighter, but if the sensor wires were accidentally touched, the transistor would be destroyed. The base resistor is therefore a protective resistor in this case.
When removing a Darlington circuit (see sensor button), the sensitivity to conductive liquids is significantly increased.

Application of circuitry in technology:
Such circuits are used in the art as sensors for monitoring liquid levels. This can be used to monitor the rise, fall or presence of a liquid (eg turning on a pump automatically if water breaks in, or shutting off the water if the hose of a washing machine bursts.) You can use the circuit as a level indicator of a bathtub or the humidity of a Monitor flower pot with it.
You've probably already wondered why a transisor is used in the circuit at all. Could not you connect the LED directly to the sensor wires? The resistance of the liquid is so high that the lamp can not light up. The transistor serves as a current amplifier. The weak base current switches a strong collector current, which makes the lamp light up.

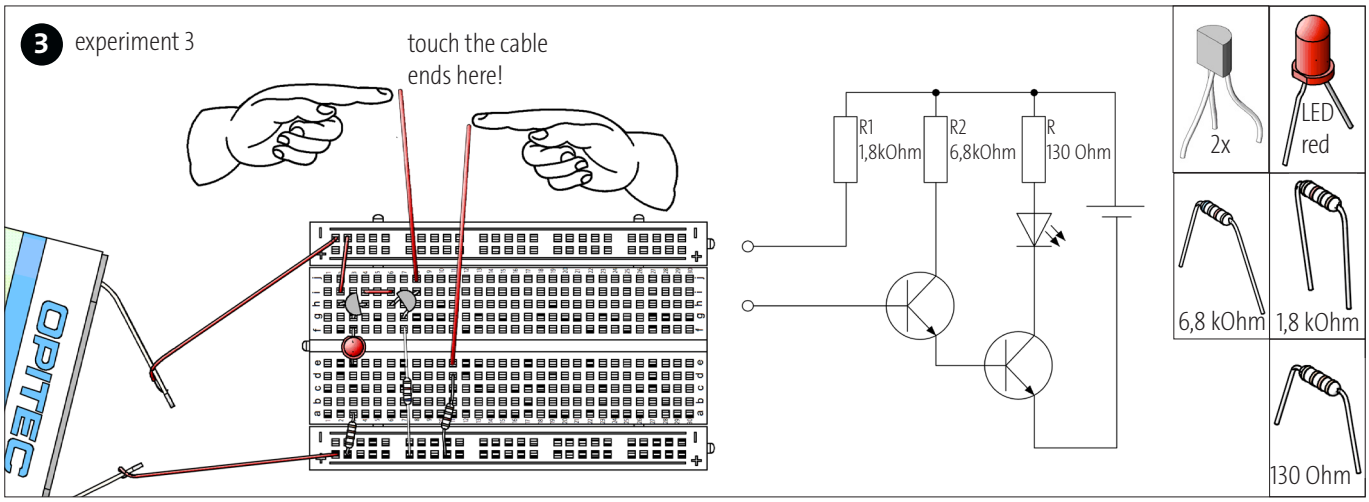
Extended Liquid Sensor
(Note: this requires an additional LED which is NOT included in the kit!) You could take an LED from a classmate!) Saved

Notes on circuit construction:
n principle, this circuit is a double implementation of the previous circuit. The advantage is that here two states are displayed. One LED indicates the attainment of a certain level of liquid, the other the decrease or rise to a certain level. Other displays would be e.g. a full or empty container. Saved
0/337 Try 2



Insert resistor 1 (130 Ohm) between +bar and terminal 3b. Plug in the LED anode at 3e and the cathode at 3f. Place the transistor T1 as follows: Insert the base at 4h, the collector at 3g and the emitter at 2h. Plug in a cable connection between -bar and 2i. Insert a cable connection between -bar and 6i. Connect the transistor T2 as follows: Plug in the base at 8i, the collector at 7g and the emitter at cable (approx. 100mm) at 7c, one cable at 4i and one cable at 8j. The ends are placed in a water container.

The touch sensor:



Insert resistor R1 (130 Ohm) between +bar and terminal 3b. Insert the resistor R2 (6.8 kOhm) between +bar and 7f. Insert resistor R3 (1.8 kOhm) between +bar and 11d. Insert the anode of the LED at 3e and the cathode at 3f. Place the transistor T1 as follows: Insert the base at 4h, the collector at 3g and the emitter at 2h. Place the transistor T2 as follows: Insert the base at 8i, the collector at 7g and the emitter at 6h. Insert a cable connection between 4i and 6i. Insert a cable connection between 2i and the -bar. Insert a cable (approx. 100mm) at 11e. Insert a cable (approx. 100mm) at 8j. The ends of these cables remain free.

Function:
In this circuit, placing a finger tip on the sensor cable ends should turn on the LED. The skin resistance of a dry fingertip is so great that only a very small amount of current can flow. This low current will not be able to switch through the simple circuit of the previously built humidity sensor. So we have to use a very high gain circuit. We built this circuit with two transistors. The way in which both transistors are connected is called the Darlington circuit.

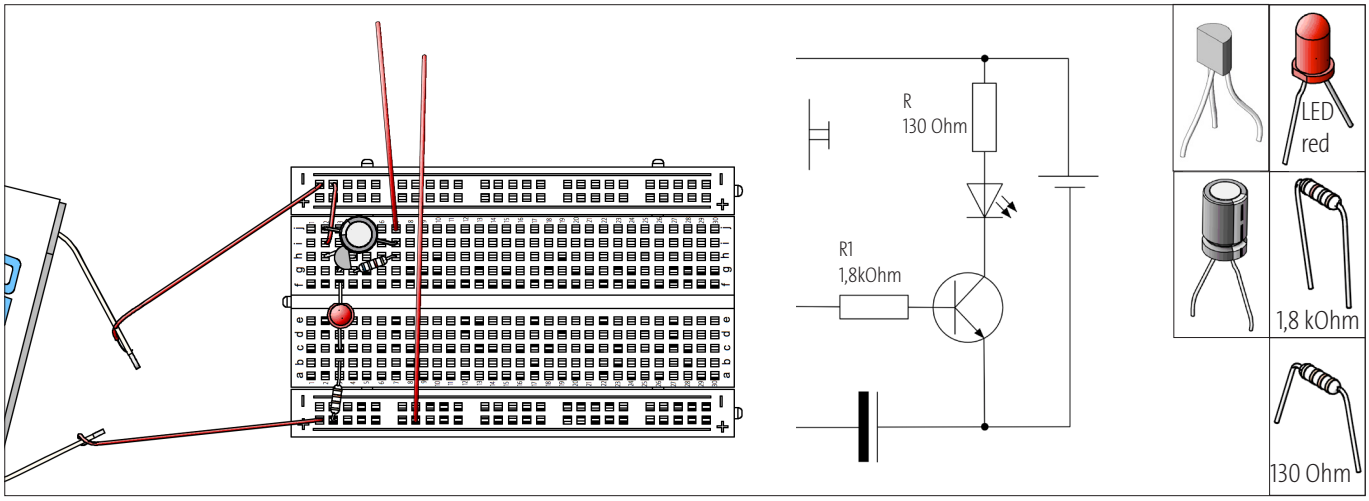
n the DARLINGTON circuit, the emitter current of the first transistor flows as a base current through the tween transistor.
Each individual transistor strengthens the current, it has e.g. a current amplification factor of β = 80. In the Darlington circuit, the gain of the two transistors is now not simply added, but multiplied. This results in a much higher factor compared to the individual circuits:

ges = ß1 x ß2 (80 x 80 = 6400)

Circuits:
If a finger tip is placed on the sensor with the battery voltage applied (up to 6V), then a base current flows through R1 and the fingertip into T1. This turns on and lets its collector current flow as a base current in the T2. The resistor R2 serves to Begranzung of the base current of T2
Transistor T2 switches on and the lamp lights up. Just because the current gain of both transistors multiplies, the low current flow through the fingertip can be used for averaging.

Application of circuitry in technology:
Such sensor circuits, in which the mere application of a finger sufficient to trigger a switching process, can be found in many consumer electronics devices.
For TVs, simply place a finger on the finger and the program is switched over, remote controls are also designed. Also in the devices that are used by the disabled, you will find such sensor circuits. Wherever electronic devices are to be operated without effort and with high comfort, sensor circuits are installed.

The time sensor

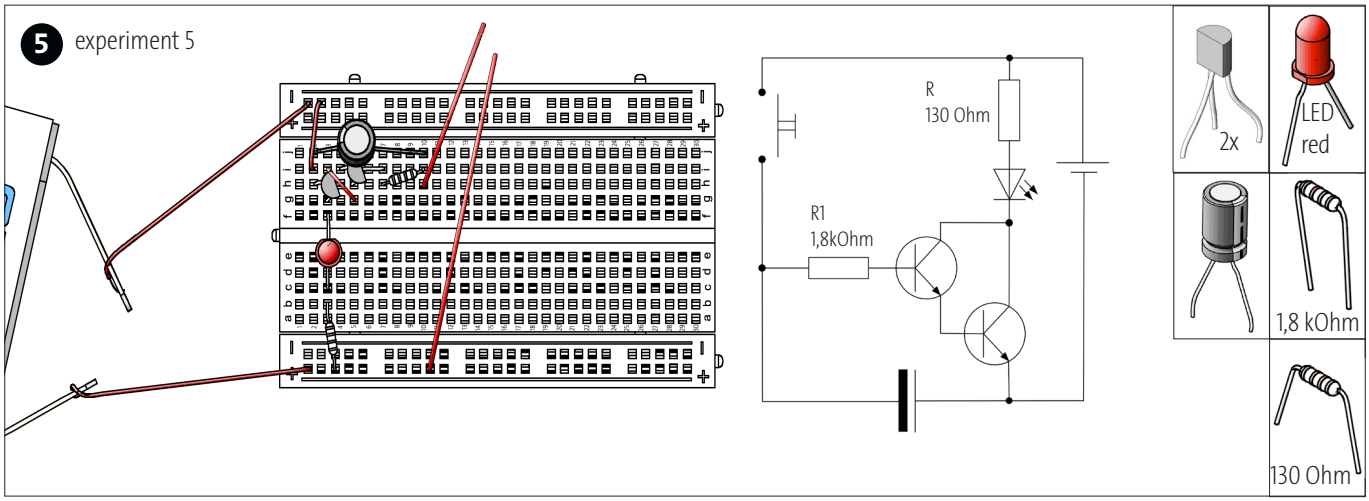


Insert the resistor 1 (130 Ohm) between +bar and 3b. Insert the anode of the LED at 3c and the cathode at 3f. Place transistor 1 as follows: Connect the base at 4h, the collector at 3g and the emitter at 2h. Insert the capacitor between 2j (-pole) and 7i (+pole). Insert the resistor (1.8 kOhm) between 4g and 7h. Plug in a cable connection between 2i and the -bar. Insert a cable (100mm) at 7j. Connect a cable (approx. 100mm) to the +bar. The ends of these two cables remain free. (Switch!)

Function:
The battery voltage (up to 6V) is applied, the lamp does not light up. Now, if the push-button cables are brought together, a base current flows through the resistor into the transisor, it turns on and the lamp lights up.
At the same time, the capacitor charges abruptly. After disconnecting the push-button cables, the light stays on. Why
The charged capacitor now discharges through the resistor and base-emitter junction of the transistor. When discharging, the current drops and the lamp shines weaker and weaker until the transistor does not turn on, the lamp goes out. The duration of the discharge depends on the size of the capacitor and the resistor. For example, causes an even larger capacitor a longer lighting time, while a small resistance shortens the lighting time, because the capacitor can discharge faster. Saved.

Application of circuitry in technology:
Such time circuits are always used in the art where uniform rhythms are needed. For example, Clock for flashing circuits, automatic switching on and off after a certain time (staircase lighting), time program of a washing machine, time-controlled data flow in a computer, time limit for electronics games, etc.
You can use the circuit to limit thinking time in guessing games or chess. Another possibility is the use for running time limitation of an engine in a ship or flight model.

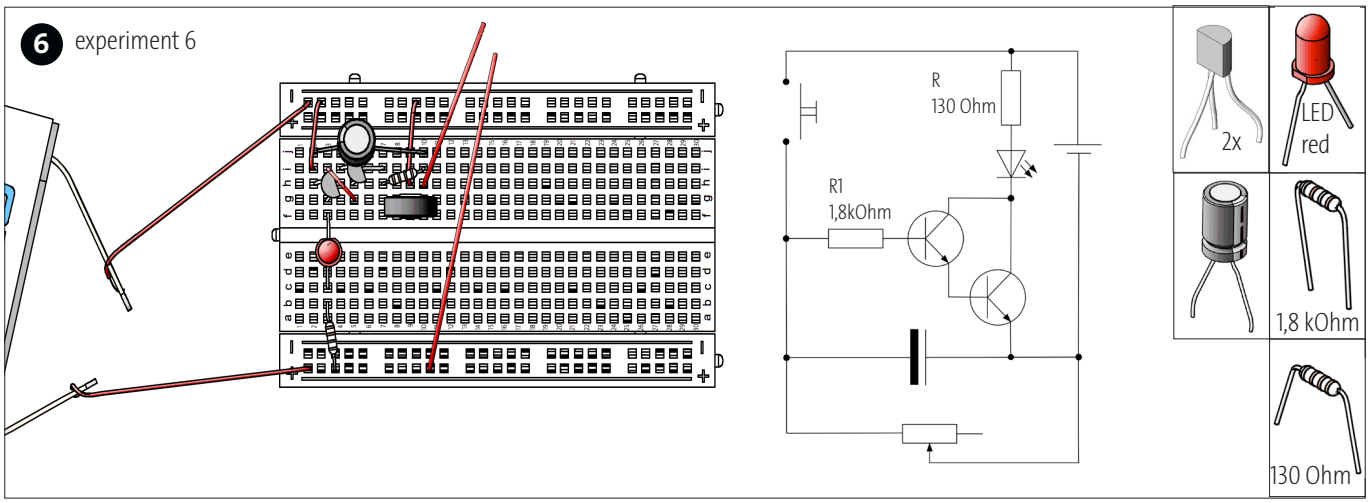
mproved time sensor (with Darlington circuit)



Insert the resistor (130 Ohm) between +bar and 3b. Plug in the anode of the LED at connection 3c and the cathode at connection 3f. Connect transistor 1 as follows: Connect the base at 4h, the collector at 3g and the emitter at 2h. Place transistor 2 as follows: Connect the base at 7i, the collector at 5h and the emitter at 4i. Insert the resistor (1.8 kOhm) between 7h and 10i. Insert the capacitor between 2j (-pole) and 10j (+pole). Plug in a cable connection between 2i and the -bar. Insert a cable (100mm) at 10h and a cable (100mm) at the +bar. The ends of these two cables remain free (switch!).

Function:
This circuit is again a Darlington circuit (see also sensor circuit). It is somewhat simple in construction because both transistors are interconnected (without a collector resistor). This circuit responds to very low currents at the base of T1 and the discharging process of the capacitor can be used over a longer time to turn T1 on. The lamp lights up for a long time. The material supply contains all required parts, you can build this circuit and use it for longer time intervals.

Improved time sensor (with trimmer (potentiometer))

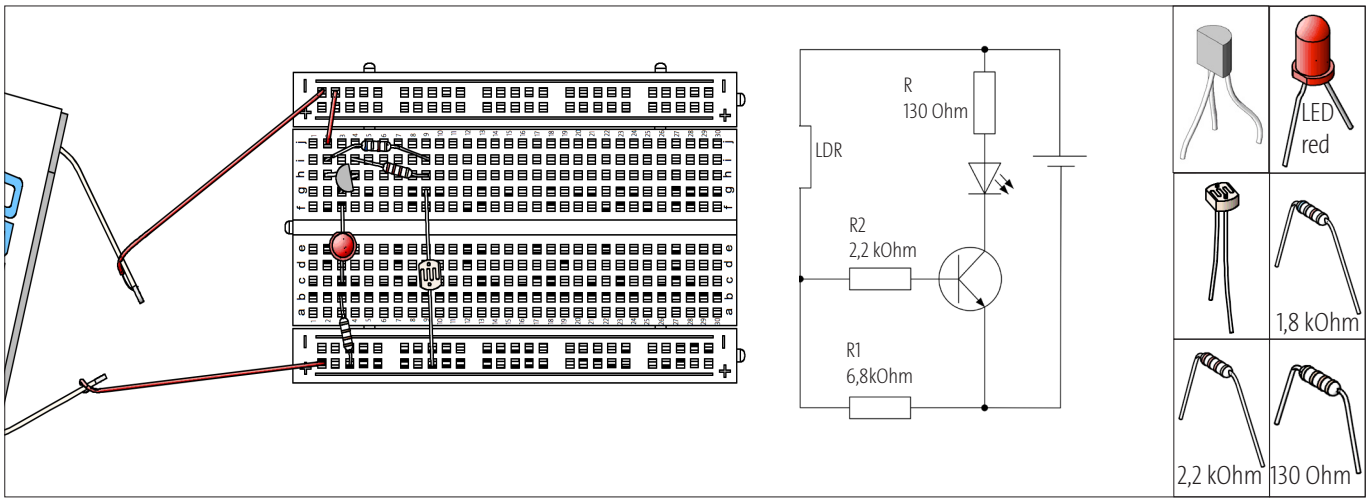


Den Widerstand (130 Ohm) zwischen +Leiste und 3b einstecken. Die Anode der LED bei 3c und die Kathode bei 3f einstecken. Den Transistor T1 wie folgt platzieren: Die Basis bei 4h, den Collektor bei 3g und den Emitter bei 2h einstecken. Den Transistor T2 wie folgt platzieren: Die Basis bei 7i, den Collektor bei 5h und den Emitter bei 4i einstecken. Den Widerstand (1,8 kOhm) zwischen 7h und 10i einstecken. Den Kondensator 2j (-Pol) und 10j (+-Pol) einstecken. Eine Kabelverbindung zwischen 3i und 5g einstecken. Ein Kabel (100mm) bei 10h und ein Kabel (100mm) bei der +Leiste einstecken. Die Enden dieser Kabel bleiben frei (Schalter). Eine Kabelverbindung zwischen 9h und -Leiste einstecken. Den Trimmer bei 10g,8g und 9h platzieren.

If you turn a trimmer (potentiometer) parallel to the capacitor, so can be set dierser circuit, the lighting time within certain limits. Compared to the simple timer can be set here the timing of switching off pretty well.

The light sensor
LDR Light Operate

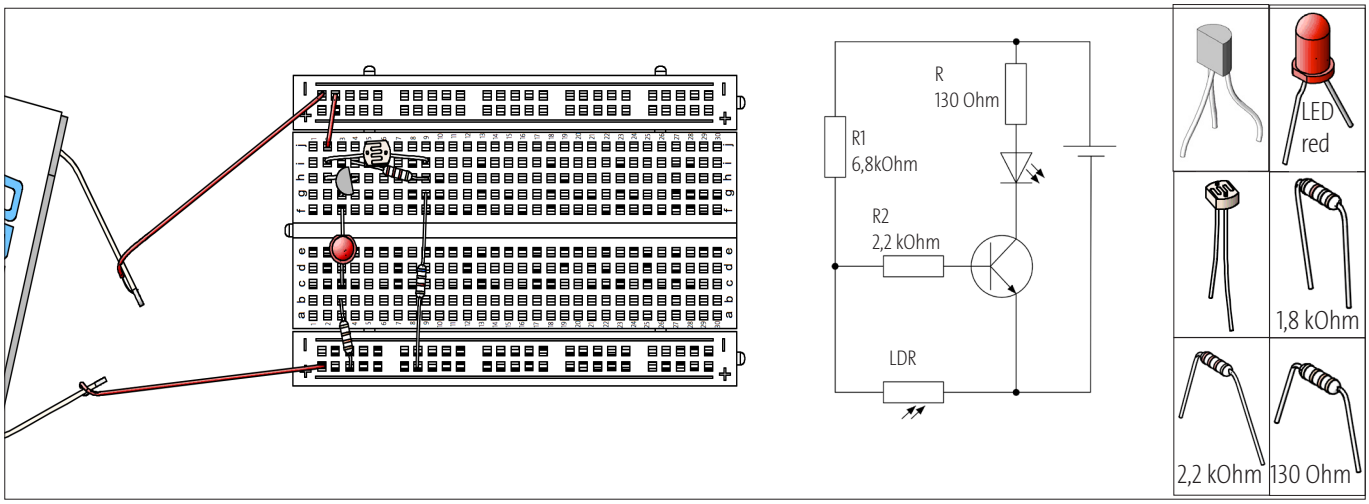
In both circuits (trial 7 + 8) pay attention to sufficient light!



Set up the LDR light circuit as follows:
Insert the resistor (130 Ohm) between +bar and 3b. Plug in the anode of the LED at connection 3c and the cathode at 3f. Place the transistor T1 as follows: Plug in the base at 4h, the collector at 3g and the emitter at 2h. Insert the resistor (2.2 kOhm) between 4i and 9h. Insert the resistor (6.8 kOhm) between 2i and 9i. Insert a cable connection between 2j and the -bar. Insert the LDR between +bar and 9g.

Function of the light circuit:
When the battery voltage (up to 6V) is applied, the LED lights up.
Why? The LDR is a photosensitive resistor, i. in the dark, it is high-impedance, but at low light impedance. Via the LDR positive potential reaches the base of the transistor, it can switch through. The resistor R2 covers the base current and protects the transistor. Resistor R1 prevents excessive current flowing through the LDR. If there is light on the LDR this would short the battery.

The light sensor
LDR dark switching



Build up the LDR dark switching as follows:
The structure is the same as for the LDR light circuit, only the resistor R1 and the LDR are swapped on the plug-in board.

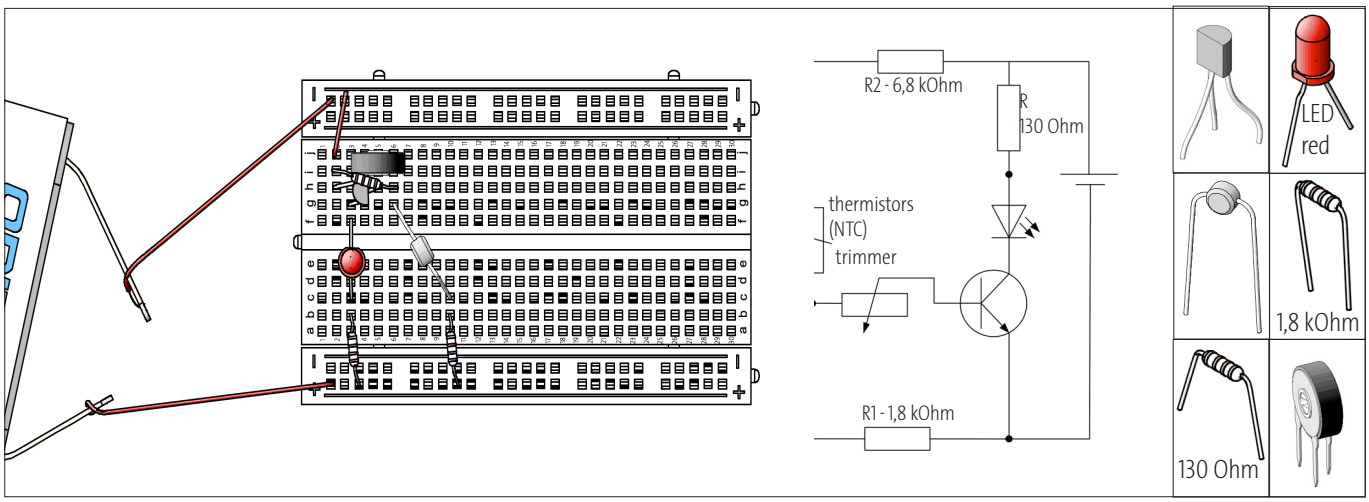
Function of the dark switching:
If the battery is connected, the LED does not light up. Why? Light falls on the LDR and it is low impedance. This causes a negative potential to reach the base, the transistor blocks and the lamp does not light up. If the LDR is darkened, it becomes high-impedance and via R1 positive potential flows via R2 into the transistor, it switches through and the LED lights up.

Instruction 118.406
Electronic Learning Programme Sensors with Breadboard

Application of light and dark switching in technology.

The best-known application is the light barrier in a department store. There, a light barrier controls the doors and escalators. Further possibilities are the automatic switching on of street lamps or parking lights at the car. The house lighting can also be switched on at sunset and switched off again at sunrise.
A circuit can be installed, for example, as an alarm system in a cabinet or drawer.
If the door is opened (without activating a secret switch) light falls on the LDR and the alarm is triggered. A buzzer can be used instead of the LED. A relay can be used to switch any number of loads and other consumers.
A light barrier can also be realized with this circuit. To do this, take the light beam of a torch and point it at the LDR, if the light beam is interrupted, the transistor switches. A cardboard tube should be pushed over the LDR, so that only light from the torch beam reaches the LDR and the ambient light cannot influence the function.

Thermal Sensor



Insert the resistor 1 (130 Ohm) between +bar and 3b. Insert the anode of the LED at 3c and the cathode at 3f. Place the transistor T1 as follows: Insert the base at 5h, the collector at 3g and the emitter at 2i. Insert resistor 2 (6.8 kOhm) between +bar and 10b. Insert resistor 3 (1.8 kOhm) between 2i and 6h. Plug in the trimmer at 4j, 6j and 5i. Insert a cable connection between 2j and the -bar.

Function of the circuit:
If a battery (up to 6V) is connected, the LED does not light up or only weakly. Why?
The hot conductor is a resistor that is highly resistive in the cold state. It only becomes low-resistance and conductive when heated, hence the designation:
thermistor. The body heat from the thumb and index finger is enough to warm up the hot conductor.

Please Note:
Never use an open flame directly on the thermistor, it could be destroyed.
The hot conductor should be cooled down before the test, e. g. put it in the refrigerator for a while!

Further heat sources could be: Hot water, hot air or hot metal if the thermistor has good contact with the metal.

When the thermistor is heated, its resistance decreases and a current flows through it and over the trimmer into the base of the transistor. The transistor switches through and the LED lights up. The resistor R1 prevents a short circuit between the hot conductor and the battery. The trimmer can be used to set a certain temperature limit. If the thermal conductor is now switched with the resistor R2, the LED lights up if the thermal conductor is not heated. When heated, it becomes low-impedance, the current flows via R1 and the hot conductor, but not into the base of the transistor and it blocks, the light goes out.

Application of circuitry in technology
Thermistors are used in technology where devices need to be switched on or off when certain temperatures are reached. For example, in order to protect equipment from excessive heating, the hot pipes switch on a ventilation system for cooling or a hot conductor in a washing machine switches off the caustic heater when the set (with a trimmer) temperature has been reached. Thermal conductors are also used to monitor liquid levels. Each heating oil tank is fitted with a heat conductor, and if the tank is filled, the level rises. At some point the level reaches the hot conductor, which cools down (heating oil is colder than air) and the electronics switches the pump off. Central heating systems are fitted with hot conductors for temperature measurement, too.
This circuit can be used as a thermostat:
If the sun shines too much on the desk, the circuit can switch a valve gate via a relay. It is also possible to melt the hot conductor at a certain point in a candle, if the candle burns down to this point, the fan blows it out. If the thermistor is immersed in a hot drinkable liquid (coffee, tea, cocoa) the lamp can indicate the drinking temperature.